

Remarks

The Official Action of June 17, 2004 states that TING et al. shows all the disclosed features of the claim 1 with the exception of the tantalum oxide film lining the contact hole, via hole or trench and being between the interlayer insulation film and the barrier layer; and heat-treating the semiconductor substrate with the tantalum-base barrier film and the copper-base conductive film in a non-oxidizing atmosphere.

The Official Action further states therein that BLISH, II et al. discloses a method of forming a metallization layer in a semiconductor structure that includes forming a tantalum-base barrier film; forming the copper-based conductive film on the tantalum-base barrier film; and heat-treating the semiconductor substrate with the tantalum-base barrier film and the copper-base conductive film in a non-oxidizing atmosphere, wherein the structure is subjected to a heat treatment after the deposition of the tantalum-base barrier film and the copper-based conductive film for the disclosed intended purpose of improving electromigration performance characteristics in an interconnection in a semiconductor device.

The Official Action also states therein that DOAN et al. shows a semiconductor device that comprises a tantalum oxide layer between an insulating film 80 and a second layer comprising tantalum, wherein the tantalum oxide layer and the tantalum layer

form layer 85 of Fig. 7, and the layers are used for the disclosed intended purpose of forming a barrier layer between copper and the insulating layer and enabling the layers to uniformly reflow during a heating step.

The Official Action concludes that it would have been obvious to one of ordinary skill in the art at the time the invention was made to heat treat the structure as BLISH, II et al. discloses and to use a tantalum oxide layer between the insulating layer and the barrier layer, for the disclosed intended purpose of improving electromigration performance characteristics in an interconnection in a semiconductor device.

Applicant submits, however, that BLISH, II et al. does not teach or suggest a heat treatment after the deposition of the copper-based conductive film 17 (Fig. 2c).

BLISH, II et al. teaches only that "although the foregoing discussion has been directed at using titanium and tantalum as barrier metals, other metals or metal compounds such as titanium nitride or titanium-tungsten, can be used provided they have a high melting point, and are sufficiently stable at ordinary metallization processing temperatures, typically 450°C, to remain amorphous" (col. 5, lines 34-40).

In summary, BLISH, II et al. teaches a heat treatment for barrier metals 14, 18 prior to deposition of the copper-based conductive film 17 (col. 5, line 23), not a heat treatment after

the deposition of the barrier metals 14, 18 and the copper-based conductive film 17.

Applicant also submits that DOAN et al. does not teach or suggest a step of forming a tantalum oxide film between an interlayer insulation film (silicon oxide film) and a tantalum-base barrier film at an interface surface therebetween, by heat-treating a semiconductor substrate with the interlayer insulation film and the tantalum-base barrier film.

DOAN et al. discloses that tantalum oxide 40 (see col. 4, line 18) is formed between first layer 30 and second layer 50, each of which comprise tantalum, copper, borophosphosilicate (BPSG) or a like (see col. 3, lines 54-58; col. 4, lines 38-42).

DOAN et al. discloses that, as shown in Fig. 5, the tantalum oxide 40 is formed superjacent first layer 30 preferably in site under high vacuum utilizing Rapid Thermal Processing (RTP) or Rapid Thermal Processing Chemical Vapor deposition (RTPCVD) principle, because both RTP and RTPCVD provide greater control of the formation of film 40 (col. 3, lines 60-65), and as shown in Fig. 6, a second layer 50 is formed superjacent film 40 by a variety of techniques, such as Chemical Vapor deposition, Rapid Thermal Processing Chemical Vapor Deposition, Low Pressure Chemical Vapor Deposition, Molecular Beam Epitaxy, Reactive Ion Sputtering, Physical Vapor Deposition or Plasma Processing (col. 4, lines 28-38).

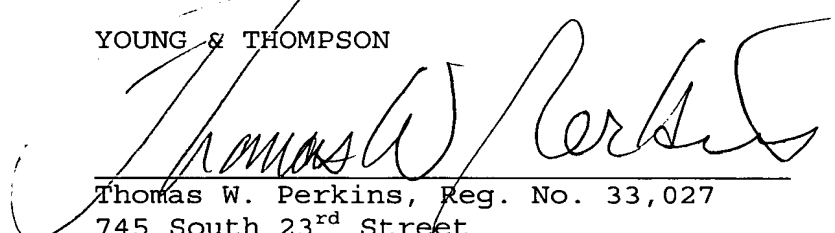
Therefore, Applicant submits that DOAN et al. does not teach or suggest a step of forming a tantalum oxide film between an interlayer insulation film (silicon oxide film) and a tantalum-base barrier film at an interface surface therebetween, by heat-treating a semiconductor substrate with the interlayer insulation film and the tantalum-base barrier film.

Therefore, the references together do not motivate one of skill in the art to pull all of these disparate steps together to form both the tantalum oxide film and the amorphous metal film at the same time by heat treating the substrate in a non-oxidizing atmosphere.

Reconsideration and withdrawal of the rejection are further solicited for these additional reasons.

Respectfully submitted,

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A large, stylized handwritten signature in black ink, which appears to read "Thomas W. Perkins". The signature is written over a horizontal line that separates the signature from the printed contact information below.

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